EFFECT OF DIFFERENT FEEDING LEVELS ON PHYSICO-CHEMICAL TRAITS FOR MAIN CARCASS CUTS OF PEKIN DUCKS IN KURDISTAN REGION OF IRAQ

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ABSTRACT

The objective of this study was to investigate the effect of different feeding levels (0%, 25%, and 50%) of alfalfa pellet ration (APR) (47% alfalfa) on the main carcass cuts Physico-chemical traits of Pekin ducks (*Anas platyrhynchos*). A total of 270 one-day-old ducklings were used. The birds at seven-day-old were assigned to 9 indoor pens of (1×2.2m) with outdoor and swimming pool (1×9.8m). Each pen represented an indoor replicate with 30 ducklings. The feeding program for Pekin Duck group treatments with (APR) (47% alfalfa) was used as a replacement to the basal diet at different percentages (0%, 25%, and 50%) for control (T0), first (T1) and second (T2) groups, respectively. At the end of the rearing period at 49 days, 6 birds (3male+3female) were randomly selected from each treatment, slaughtered and each breast and thigh muscle was excised for meat quality analysis. The results showed that treatments and sex did not significantly influence meat Cholesterol content, and most results for each of cooking loss, color, pH, chemical composition, and amino acid profile of the meat. In contrast, they had a significant effect on most fat and water-soluble vitamins, and fatty acid profiles. In general, feeding ducks with a 25% of APR improved eth color of breast, and fat-soluble vitamins with Cholesterol in both breast and thigh muscle while feeding ducks with a 50% APR improved most Physico-chemical traits.

Keywords: Vitamins, breast, thigh, ration, fatty acid, amino acid, birds
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تأثير مستويات مختلفة من التغذية على الصفات الفيز وكيميائية للأجزاء الرئيسية في الذبيحة لبط البكيني في أقليم كوردستان العراق

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المستخلص

أستهدفت هذه الدراسة إلى معرفة تأثير مستويات التغذية المختلفة لعلف أقراص الجت على الصفات الفيز وكيميائية للأجزاء الرئيسية في الذبيحة لبط البكيني. تم إحضار 270 فرخة عمرها يوم واحد من مفقس مزرعة نوروز – أربيل. تم تخصيص 9 حظائر داخلية مغلقة بمساحة (1 × 2.2 م) لأفراخ عمر 7 أيام ومع مساحات خارج الحضيرة وحوض السباحة (1×9.8 م)، وكان كل حضيرة يمثل تكرارًا داخليًا به 30 فرخة بط. وتم اتباع برنامج التغذية لمعاملات مجموعة البط البكيني باستخدام علف أقراص الجت (47٪ الجت) كإحلال من الغذاء الأساسي وبنسبة مئوية مختلفة (0٪، 25٪ و50٪) لثلاث مجموعات على التوالي. في نهاية فترة التربية، تم اختيار 6 طيور(3 ذكور+3 أناث) بشكل عشوائي من كل معاملة وذبحها، وتم استئصال كل من عضلات الصدر والفخذ لتحليل جودة اللحوم. أظهرت النتائج أن المعاملات والجنس لم تؤثر معنوياً على محتوى الكوليسترول ومعظم النتائج الخاصة بفقدان الطبخ، اللون، درجة الحموضة، التحليل الكيميائي والأحماض الأمينية، وفي المقابل كان لها تأثير معنوي على محتوى معظم الفيتامينات الذائبة في الماء والدهون والأحماض الدهنية. بشكل عام، تغذية البط بنسبة 25٪ من علف أقراص الجت أدت إلى تحسين لون الصدر، والفيتامينات الذائبة في الدهون مع الكوليسترول في كلا الصدر و الفخذ، في حين أن تغذية البط بنسبة 50٪ من علف أقراص الجت أدت إلى تحسين معظم الصفات الفيز وكيميائية.

الكلمات المفتاحية: الفيتامينات، الذبيحة، الصدر، الفخذ، العلف، الزيادة الوزنية، الطيور
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INTRODUCTION

The Pekin duck was created in the second half of the nineteenth century. Commercial Pekin ducks are most often reared for meat and have snow-white plumage. These ducks are characterized by a fast growth rate, high slaughter weight, good feed conversion, high viability, relatively low nutrient requirements compared to broiler chickens, great tolerance to harsh raising conditions, and considerable to disease immunity (17). The number one duck meat producer was China, which produced about two-thirds of the total world production (10). Pekin-type broiler ducks are raised intensively from 6 to 7 weeks, and under a backyard system from 9 to 10 weeks. Ducks are a great choice for backyard and organic farming for the reasons mentioned above as well as the excellent conversion of farm feeds (forages, feed roots, dried feeds, silages) and by-product feeds (5). The Pekin-type duck carcass is a favorite among poultry farmers and is distinguished by having more red muscle fibers in the breast muscle than chicken meat. In general, duck meat is thought to be flavorful, high in polyunsaturated fatty acids, and amino acids, and relatively little fat. With respect to the overall content of polyunsaturated fatty acids, duck meat has a high content of linoleic and linolenic fatty acids (27). Furthermore, Alfalfa (*Medicago sativa L.*) in ducks feed, is primarily grown for and used in animal feed, as it is a good source of easily assimilated protein and high in minerals and vitamin content. Based on this potential, alfalfa pellet ration can be utilized as a food replacement to reduce cholesterol and enhance the quality of duck meat. Duck meat has also a favorable profile of essential amino acids (including relatively high amounts of lysine) and the highest content of unsaturated fatty acids among all poultry species. It is a source of fat-soluble vitamins (mainly A and E) and water-soluble vitamins (B1, B2, and PP) (16). The aim of this study was to investigate the effect of different alfalfa pellet ration levels on Physico-chemical traits for the main carcass cuts breast and thigh of Pekin ducks in Kurdistan region of Iraq.

MATERIALS AND METHODS

Management and Design of Experiment: This study was conducted at the private field Nowruz farm - Qushtapa - Erbil during the period from 9 Sept. 2020 until 11 November 2020 using different feeding levels for Pekin Duck (*Anas platyrhynchos*). A total of 270 one-day-old ducklings were brought from Nowruz farms hatchery – Erbil. The birds at seven-day-old were assigned to 9 indoor pens (1×2.2m) with outdoor and separated swimming pools (1×9.8m); each box represented an indoor replicate with 30 ducklings. The feeding program for Pekin Duck group treatments about (starter, growing, and finisher), and alfalfa pellets ration (47% alfalfa) were used at different levels (0%, 25%, and 50%) for three groups respectively, feed and water were provided *ad libitum*. Basal diet ingredients, Alfalfa pellet ration ingredients, and calculated chemical composition of the mixed them are shown in Table (1, 2, 3), respectively. The duckling was in a clean well-ventilated hall and belonged to a regular healthy program applied on the farm. All ducklings were vaccinated (Table 4). In the first week, the ducklings were fed collectively *ad libitum* on the starter full requirements of the Basal Diet reared indoor house according to NRC [26] only and freely in a hall where the number of lighting hours was about 22 hours, and with an area of 27 birds / m2. Vitamin C was given about 1 g/ 1 liter of water after vaccination of the ducklings with Newcastle and influenza on three consecutive days. The multi-vitamin was also given by drinking water 1 ml / 1 liter of water three times a day for three consecutive days during the first week of the experiment. To improve the amount of feed intake, the alfalfa pellet ration was crushed and presented during the first week of the experiment. Also, 6 ml / 1 liter water di-calcium phosphate was given in liquid form, from 2 to 4 weeks of age, for three consecutive days each week. Birds were randomly divided into three treatment groups of three replicates / treatment of 30 birds / replicate at one week's age, and then different dyeing color was used to label each treatment. The treatments were as follows; control treatment group: as control (T0) fed full requirements of basal diet according to NRC

(26), first treatment (T1): birds fed %25 alfalfa (Medicago sativa) pellet ration + 75% of full requirements of basal diet, second treatment (T2): birds fed %50 alfalfa pellet ration + 50% of full requirements of basal diet. From 15 days, birds are enabled to reach the swimming pool (10m×1m×30cm) through separate holes from indoor to outdoor. The measures of the area in indoor and outdoor with swimming pool 1 × 12 m (1 m2/4 bird) for each pen and separated by fences. The outdoor area was designed to provide birds with natural behavior. All birds were supplied with clean water *ad libitum* as well as a clean water pool.

Table 1. Basal Diet ingredients (%).

Ingredients	Starter 1-14 days	Grower 15-35 days	Finisher 36-49 days
Wheat	19.5	23	18.6
Wheat bran	1	2.5	4
Wheat flour	10	10	15.5
Corn	23	24	30.5
Soybean	39.85	34.3	24.7
Oil	1.85	1.5	2
Limestone	1.9	1.8	1.8
Premix	2.5	2.5	2.5
Optifeed*	0.005	0.005	0.005
Oleobiotec*	0.005	0.005	0.005
VeO*	0.005	0.005	0.005
Lysin	0.02	0.03	0.04
Methionine	0.05	0.05	0.05
Avimatrix**	0.05	0.05	0.05
Herb – All (COCC-X) ***	0.05	0.05	0.05
Antitoxin	0.075	0.075	0.075
Chemical composition (%)			
Protein	23	22	18.5
Metabolic Energy(Kcal/Kg)	2850-2900	2900-3000	3000-3100
Moisture	11	10.9	10.5
Fat	3.4	3.8	3.5
Fiber	3.6	3.5	4.0
Ash	5.1	5.0	4.8

*** It is a mix of flavoring substances.**

**** It also contributes to improving feed conversion and optimal production efficiency.**

***** It is a complementary feed to improve and strengthen gut health for all animal species**

Table 2. Alfalfa pellet ration ingredients (%).

Ingredients	%
Alfalfa	47
Soybean	8.6
Wheat bran	2.5
Wheat flour	33.6
Oil	2
Sodium carbonate	0.3
Antitoxin	0.1
Dicalcium phosphate	0.5
Limestone	2
Salt	1
Premix (vitamins, Lysin, Methionine, and minerals)	1
Dates juice	1.5
Chemical composition (%)	
Protein	15.9
Metabolic Energy (Kcal/Kg)	2400 - 2600
Moisture	12.0
Fat	1.3
Fiber	8.8
Ash	8.1

Health control of Pekin duck

The duckling was in a clean well-ventilated hall and belonged to a regular health program. All ducklings were vaccinated based on production purposes.

Evaluation of meat Physico-chemical traits

Cooking loss: The muscle samples from the breast and thigh were transferred from the -18°C freezer into a 4°C cooler overnight to thaw. The defrosted samples were individually weighed and documented as initial weight (W1). The samples were then placed in plastic bags and cooked in a water bath for 20 minutes at 80°C. The cooked samples were removed from the plastic bags and cooled in an ice slurry for 20 minutes. The samples were weighed once again and then written as W2 (cooked weight). The following equation was used to determine the cooking loss based on the weight differences between raw and cooked meat:\

Cooking loss (%) = [(W1 − W2) ÷ W1] × 100.

According to the method recommended by Abdullah *et al.* (1).

Color measurement: Breast and thigh samples were taken out of the -18°C freezer and allowed to defrost overnight at 4°C. Prior to color measurement, they were taken out of the packaging and given 20 minutes to bloom in the air. A Color Flex Spectrophotometer (Shenzhen 3nh Technology Co., Ltd,

China) was used to measure the color of the meat. Prior to use, the device was initially calibrated against black-and-white reference tiles. On each sample, L* (lightness), a* (redness), and b* (yellowness) were measured in triplicate (1).

Table 3. Calculated chemical composition (%) of the mixed Basal diet and Alfalfa pellet rations.

Chemical composition (%)	Starter 7-14 days T0 Control BD* (100%)	Starter 7-14 days T1 APR** (25%) + BD (75%)	Starter 7-14 days T2 APR (50%) + BD (50%)	Grower 15-35 days T0 Control BD (100%)	Grower 15-35 days T1 APR (25%) + BD (75%)	Grower 15-35 days T2 APR (50%) + BD (50%)	Finisher 36-49 days T0 Control BD (100%)	Finisher 36-49 days T1 APR (25%) + BD (75%)	Finisher 36-49 days T2 APR (50%) + BD (50%)
Protein	23	21.225	19.45	22	20.475	18.95	18.5	17.85	17.2
Metabolic Energy (Kcal/Kg)	2850-2900	2737.5-2825	2625-2750	2900-3000	2775-2900	2650-2800	3000-3100	2850-2975	2700-2850
Moisture	11	11.25	11.5	10.9	11.175	11.45	10.5	10.875	11.25
Fat	3.4	2.875	2.35	3.8	3.175	2.55	3.5	2.95	2.4
Fiber	3.6	4.9	6.2	3.5	4.825	6.15	4.0	5.2	6.4
Ash	5.1	5.85	6.6	5.0	5.775	6.55	4.8	5.625	6.45

*** BD: Basal Diet ** APR: Alfalfa Pellet Ration T0: Control T1: First treatment T2: Second treatment**

Table 4. Vaccination program for Pekin duckling

Age Day	Vaccine	Route
3	IB Ma5+ ND Clone 30	Spray
7	InfluenzaH9N2+ ND	Injection

pH muscle determination: A digital pH meter was used to indirectly measure the pH of the breast and thigh muscles under three post-mortem conditions: pH_{60} (one-hour post-slaughter), pH_{24} (24-hour post-mortem), and pH_f (post-freezing) (Electronic Co. Ltd, China). Before each use, the pH meter's calibration was done at pH 4.0 and pH 6.8. Each crushed muscle sample weighed around 0.5 g, which was then homogenized for 20 seconds in 10 ml of ice-cold double distilled water. The pH of homogenates was determined using the pH meter's electrode. Each sample was measured three times, and for each treatment, the average pH value was calculated., and also according to the technique suggested by Abdullah *et al.* (1).

Proximate composition

Following AOAC (3) guidelines, the breast and thigh meat's composition was identified. Moisture was calculated by drying 50 g of meat at 100-105°C until it attained a constant weight. The Kjeldahl method was used to calculate crude protein. The crude protein was gained as 6.25 × N%. The Soxhlet extraction technique and petroleum ether were used to calculate the meat's fat content. By burning the sample at 550°C for 3 hours in a muffle furnace, the amount of Ash in the meat was determined.

Vitamins: Fat soluble vitamins A, D, E, K were determined by using the liquid chromatography technique (HPLC) model (SYKAMN – Germany) in the laboratory of the Ministry of Science and Technology – Baghdad - Iraq, the column separation was (C18 – ODS (25 cm * 4.6 mm) and the mobile phase was methanol–water (98:2, v/v). The mobile phase flow rate was 1.0 mL/min, and the injection volume was 50 µL. The column oven temperature was 35°C. Detection with a UV–vis detector was carried out at 265 nm According to the procedure mentioned by Xue *et al.*, (39). Water soluble vitamins (B2, B3, B5, B6, B12, C) were determined by using HPLC model SYKAMN (Germany) It was used to analyses add detection of thiamethoxam. The mobile phase was an isocratic acetonitrile: D.W: formic acid (50: 47: 3) at flow rate at 1.0 mL/min, column was C18 – ODS (25 cm * 4.6 mm) and the detector UV- 215, 210 nm according to (33).

Fatty acid profile and cholesterol

Fatty acid was determined by using the Gas chromatography (GC-2010) model (Shimadzu – Japan) in the laboratory of the Ministry of Science and Technology – Baghdad - Iraq, the column separation was (SE- 30) (30m * 0.25 mm), and it used Flame Ionization Detector (FID). The gas flow rate was 100 Kpa (Kilo

pascal). The injection temperature was 280°C and indicator temperature was 310°C. The separator column temperature was 120 – 290°C (10°C / MIN), According to (38). Cholesterol in breast and thigh samples was extracted and determined by HPLC and using equipment as described in Maiorano *et al.* (23).

Amino acid profile: The amino acid was determined by using the amino acid analyzer-Korea in the laboratory of the Ministry of Science and Technology – Baghdad - Iraq, the column separation was ZORBAX Eclipse-AAA; 3.5µm; L x i.d.=150 x 4.6 mm to separate amino acids. The mobile phase was acetonitrile: methanol: formic acid (60: 20: 20) rates with flow rate 1 ml / 1 min. The gas flow rate was 100 Kpa (Kilo pascal). The injection temperature was 280°C and indicator temperature was 310°C. The separator column temperature was 120 – 290°C (10°C / MIN), According to Dahl-Lassen *et al.* (7).

Statistical Analysis: The experiment was designed as Complete Randomized Design (CRD). Data were analyzed using the program of Statistical Analysis System (32), The effect of sex (male or female) was added to the module of all traits. To diagnosing the significant differences between treatments, the proceeding of Duncan's multiple range tests at level of P< 0.05 was detected (9).

RESULTS AND DISCUSSION

Cooking loss: The effect of the replacement of alfalfa pellet to the basal diet on cooking loss in Pekin duck's breast and thigh meat is shown in Table 5. Irrespective of the treatment, no significant differences ($p > 0.05$) on the cooking loss was observed in breast muscles among birds fed the control and those fed basal diets with replacement alfalfa pellet after freezing storage, and the first treatment (T1) gave higher cooking loss (30.15%) than in the second treatment (T2) (28.57%) and control (T0) (26.39%) for breast respectively, while control (T0) (28.52%) and (T1) (26.64%) was higher significantly ($p < 0.05$) than (T2) (20.31%) for thigh respectively. Regarding sex effect, the cooking loss was lower ($p > 0.05$) in the breast of males than in females, and high in the thigh of females than in males (Table 5). Addini *et al.*, (2) reported similar findings where birds fed alfalfa supplementation of 5% and 10% had higher cooking loss% than the control of hybrid duck meat. However, He *et al.*, (15) referred to similar findings too in their study on broilers where fed alfalfa meal supplementation of 25g/kg, 50g/kg, and 75g/kg feed had no significant effect on cooking loss% in comparison with the control in the breast but different findings in the thigh which showed no significant differences on cooking loss%. In contrast, Kokoszynski *et al.* (18), showed in their study on Pekin duck and commercial crossbreds that sex effect on breast and legs, females recorded lower than males of Pekin ducks in the breast but similar results in leg that males had lower cooking loss than females in commercial hybrid Pekin ducks. However, other studies referred that those of males and females had no significant differences ($p > 0.05$) in breast and leg (21, 20).

Table 5. Effect of treatments and sex on cooking loss (%) of breast and thigh.

Factors	Breast	Thigh
Over all mean	28.37	25.16
Treatments	NS	*
T0	26.39±1.25	28.52±0.31a
T1	30.15±1.54	26.64±1.09a
T2	28.57±1.16	20.31±0.83b
Sex	NS	NS
M	27.83±1.38	25.69±2.28
F	28.91±1.39	24.62±2.74

Means followed by the different letters in the same column are significantly different (P<0.05). *: P<0.05 NS: non-significant

Color values: Table 6 displays the color coordinates of the breast and thigh meat of Pekin ducks fed various levels of dietary treatments. The first group samples (T1) indicated lower lightness (L*) and high redness (a*) ($p < 0.05$) with yellowness (b*) of the breast, and females recorded lower lightness (L*) and higher yellowness (b*) than males. On the other hand, the second group samples (T2) indicated lower lightness (L*) and high redness (a*) ($p < 0.05$) with yellowness (b*) of the thigh, and males recorded higher in all traits than females. However, there were no significant differences ($p > 0.05$) in different feed levels on the yellowness color of breast and thigh, and sex on the color of breast and thigh samples among birds. This observation corroborates the report of Tayeb *et al.*, (35), who indicated that the effects of different levels of medical plants

supplemented in the diet and sex on lightness, redness, and yellowness of the meat color of broiler chicken didn't have a significant effect among treatments compared to the control group. However, He *et al.,* (15), observed that the b* of breast muscles increased when Alfalfa meal was added to the diet, compared to the control ($p < 0.05$). However, a* and L* of the breast and thigh muscles were not affected by the Alfalfa meal addition. Compared with control chicken, Alfalfa meal chickens showed an increasing trend of b* in their thigh muscles. Michalczuk *et al.,* (23) noted significantly higher redness a* values of breast muscles in females than in males, while Gornowicz *et al.,* (12) did not observe any significant differences in the redness of breast muscles between males and females. Kokoszynski *et al.,* (19) reported that males showed significantly lower redness ($P=0.002$) of breast muscles in Muscovy duck. The darker color from the analyzed Muscovy ducks resulted from a significantly higher content of hem pigments compared to the breast muscles of Pekin ducks. This was probably related to better blood supply to the muscles in older Muscovy ducks. A study by Banaszak *et al.,* (4) on two groups of Cherry valley meat ducks fed 650g/kg soybean meal and 689.89g/kg yellow lupin in concentrates, showed significantly greater ($p <0.05$) lightness (L*) and yellowness (b*) in the breast muscle of group 2 compared to group 1, but did not significantly differ for the color of the leg muscles. The greater lightness (L*) and yellowness (b*) of muscles from ducks fed yellow lupin may indicate a higher concentration of carotenoids in lupin as well as a higher intramuscular fat content in muscles. Similarly, a* parameter values between the two groups in this study could be interpreted as a similar red muscular fiber composition in duck muscles. The lighter meat has a higher L* value. This parameter can also be related to the pH of meat. Zhuang and Savage (42) found that dark meat has a lower L* value and a higher pH, while light meat has a higher L* value at a lower pH. Furthermore, Kokoszynski *et al.,* (20), reported that significant ($p<0.05$) differences were observed in the color parameters of breast muscles and in the redness of leg muscles between males and females within two genetic groups of ducks. However, the study by Boz *et al.,* (6) on Turkish geese varieties, indicated that significant differences ($p<0.05$) were observed in the yellowness of breast and thigh meat colors in lightness and yellowness between males and females.

pH values: Table 7 displays the pH values of the breast and thigh meat of Pekin ducks sex-wise. pH values of different treatments decreased from pH_{60} (one-hour post-slaughter) to pH_{24} (24-hour post-mortem) and significantly ($p<0.05$) from pH_f (post-freezing) in the breast. The breast and thigh of birds fed different percentages of Alfalfa pellet ration had lower pH than those from the control group, and breast females had lower pH than males and with significant differences between males and females in pH_{24} (24-hour post-mortem) and pH_f (post freezing) but, in the thigh, males had lower pH than females. The post-mortem conversion of muscle glycogen to lactic acid may have contributed to the pH drop. The only source of energy for the post-mortem muscles in a bird that has been exsanguinated and subsequently suffers from hypoxia is anaerobic glycolysis, which eventually becomes necessary for the muscle cells' remaining metabolic processes (30). Glycogen stores are thus reduced when they are converted to lactic acid, resulting in a decrease in pH. The pH of muscle is an important indicator of various quality traits in meat. Similar findings were concluded by He *et al.,* (15), who showed no significant differences in pH_{45} minutes and pH_{24} hours between treatments using different quantities of Alfalfa meal 25g/kg, 50g/kg, and 75g/kg diet of breast and thigh in the broiler. However, Banaszak *et al.,* (4), reported similar findings too for non-significant ($p > 0.05$) in pH_{15} and pH_{24} between two groups of Cherry valley meat ducks fed soybean meal (group 1) and yellow lupin (group 2) in diet, a change of protein source in duck diet had no significant effect on pH traits ($p > 0.05$). The decrease in pH between 15 min and 24h post-mortem indicates correct glycolysis in breast muscles and was associated with the accumulation of lactic acid. Addini *et al.,* (2), indicated significant differences ($p < 0.05$) between different levels of Alfalfa 5% and 10% with

control in pH of hybrid duck meat. Alfalfa's crude fiber is one of the feeds that affects the pH value. Higher alfalfa supplementation can reduce the meat's pH. Kokoszynski *et al.*, (21), reported that the pH_{24} of breast muscles had significant differences ($p < 0.05$) between females in different genetic groups, pH_{24} post-mortem of leg muscles did not differ shown. The leg muscles showed higher pH values measured 24 hours post-mortem compared with the breast muscles. Furthermore, Kokoszynski *et al.*, (20), reported that the sex of birds did not have a significant ($p > 0.05$) effect on the acidity (pH_{24}).

Proximate composition: There were no significant differences in breast and thigh proximate analysis, except breast protein content showed significant differences among treatments (Table 8). The breast meat from the control birds (T0) had the highest protein and fat content which was significantly different ($p < 0.05$) in protein content than the first treatment (T1).

Table 6. Effect of treatments and sex on the breast and thigh color

Color	Meat muscle	Overall mean	Treatments			Sex		SEM	P-value	
			T0	T1	T2	M	F		Treatments	Sex
L* Lightness	Breast	37.07	36.40ab	34.19b	40.64a	37.44	36.71	0.67	0.023	0.675
a* Redness		18.38	17.70ab	20.48a	16.95b	18.39	18.36	0.44	0.069	0.985
b* Yellowness		9.29	8.24	10.78	8.84	8.32	10.26	0.50	0.322	0.182
L* Lightness	Thigh	42.66	50.61a	41.96ab	35.40b	42.87	42.45	1.58	0.027	0.919
a* Redness		13.74	10.69b	14.15ab	16.38a	14.28	13.21	0.60	0.030	0.500
b* Yellowness		9.49	7.90	9.32	11.25	10.99	7.99	0.59	0.254	0.078

Means followed by the different letters in the same raw are significantly different (P<0.05). SEM: Pooled Standard Error of the Mean

Table 7. Effect of treatments and sex on the pH of breast and thigh muscles

pH measures	Meat muscle	Overall mean	Treatments			Sex		SEM	P-value	
			T0	T1	T2	M	F		Treatments	Sex
pH_{60}	Breast	6.26	6.37	6.18	6.23	6.34	6.17	0.04	0.203	0.099
pH_{24}		6.09	6.20	6.02	6.05	6.22a	5.95b	0.05	0.246	0.049
pH_f		6.02	6.08a	6.03b	5.93c	6.12a	5.91b	0.03	0.012	0.002
pH_{60}	Thigh	6.49	6.56	6.43	6.47	6.47	6.50	0.02	0.171	0.493
pH_{24}		6.33	6.35	6.31	6.34	6.32	6.35	0.01	0.350	0.199
pH_f		6.25	6.26	6.26	6.24	6.25	6.26	0.01	0.694	0.789

Means followed by the different letters in the same raw are significantly different (P<0.05). SEM: Pooled Standard Error of the Mean. pH_{60}: pH one-hour post-slaughter. pH_{24}: pH 24-hour post-mortem. pH_f: pH post freezing

Table 8. Effect of treatments and sex on the breast and thigh chemical composition

Chemical composition	Meat muscle	Overall mean	Treatments			Sex		SEM	P-value	
			T0	T1	T2	M	F		Treatments	Sex
Protein%	Breast	21.19	22.00a	20.09b	21.47a	20.47b	21.90a	0.29	0.019	0.012
Fat%		8.10	9.42	7.25	7.64	8.04	8.16	0.56	0.661	0.956
Ash%		1.33	1.39	1.28	1.33	1.31	1.36	0.04	0.793	0.744
Moisture%		70.12	68.14	71.44	70.79	70.88	69.37	0.57	0.328	0.395
Protein%	Thigh	19.66	20.21	19.28	19.5	19.52	19.80	0.20	0.553	0.697
Fat%		8.24	8.39	9.90	6.41	7.53	8.94	0.59	0.358	0.447
Ash%		1.10	1.13	1.09	1.06	1.11	1.09	0.02	0.735	0.779
Moisture%		71.08	70.40	69.39	73.44	71.25	70.90	0.61	0.278	0.841

Means followed by the different letters in the same raw are significantly different (P<0.05). SEM: Pooled Standard Error of the Mean

Nevertheless, there was no significant difference in breast and thigh fat contents ($p > 0.05$) among birds fed diets T0, T1, and T2. The lower fat content observed in the T1 in the breast, and T2 in the thigh birds as compared to the control group, and in the male breast and thigh lower protein and fat content than females which were in line with the reports were recorded, the present results suggest that the replacement of alfalfa pellet ration (50%) to the basal diet recorded lower fat% of thigh meat than others in Pekin ducks. Addini *et al.*,

(2), reported that alfalfa supplementation in commercial feed significantly affected the water content of hybrid duck meat ($p < 0.05$). The highest water content was at the alfalfa supplementation of 10%, while the lowest water content is at the level of alfalfa supplementation of 5%, and no significant differences ($p < 0.05$) on the crude protein. Based on the measured amino acid contents, these results indicated that alfalfa can be a suitable alternative for other feed materials that provide the necessary amount of several amino acids for poultry including corn meal (lysin and tryptophan), soybean meal (methionine, cysteine, lysine, and tryptophan) and fish meal (methionine and lysine) (34). He *et al.*, (15), reported that the effects of dietary alfalfa meal addition on meat quality parameters of broilers that the thigh muscle crude protein was lower in the alfalfa meal group than in the control group ($p < 0.05$), while there were no significant differences in terms of breast muscle crude protein. No significant differences were found in the Ether Extract of the thigh and breast muscles. In addition, the study by Palupi *et al.*, (28) concluded that 0.5% of propionic acid added to the diet might improve the carcass quality of the broiler. Galal *et al.*, (11), who referred that the male ducks had significantly higher water and protein but had significantly lower fat and ash content in breast and thigh muscles compared to female ones. Kokoszynski *et al.*, (19), reported that the sex of ducks had a considerable ($p < 0.05$) effect on basic chemical composition (water%, protein%, fat%) of the breast and leg meat. However, the study by Kokoszynski *et al.*, (20) indicated that males contained significantly less fat in breast muscles and significantly more water and protein, and less ($p < 0.05$) fat in the leg muscles than in females. Boz *et al.*, (6), who referred that crude fat in breast meat was higher in male geese ($p < 0.05$) than in females. The effects of sex of other meat characteristics (Protein%, Ash%, Dry matter%) were not significant.

Vitamins: Fat-soluble vitamins: The effect of the replacement of alfalfa pellets to the basal diet on fat-soluble vitamins in Pekin duck's breast and thigh meat is shown in Table 9. The first group samples (T1) indicated high content (ppm) of fat-soluble vitamins than the second group (T2) and control (T0) respectively. The replacement of the alfalfa pellet ration to the basal diet had a significant influence ($p < 0.05$) on the fat-soluble vitamins except vitamin D which influenced not significantly ($p > 0.05$) in comparison with control, and both breast and thigh females had a higher significantly ($p < 0.05$) content of fat-soluble vitamins than males (Table 9).

Water-soluble vitamins: The effect of the treatment and sex on water-soluble vitamins in the breast and thigh meat of Pekin duck is shown in Table 10. The second group samples (T2) indicated high content of water-soluble vitamins (ppm) than the first group (T1) and control (T0) respectively. The replacement of the alfalfa pellet ration to the basal diet had a significant influence ($p < 0.05$) on the water-soluble vitamin content in the breast and thigh in comparison with control, and both breast and thigh males had a higher significant content ($p < 0.05$) of most water-soluble vitamins than females (Table 10).

Table 9. Effect of treatments and sex on fat-soluble vitamins (ppm) in the breast and thigh

fat-soluble vitamins	Sample	Overall mean	Treatments			Sex		SEM	P-value	
			T0	T1	T2	M	F		Treatments	Sex
A	Breast	21.19	18.95b	22.87a	21.75a	18.87b	23.51a	0.76	0.010	0.003
D		0.80	0.60	0.88	0.91	0.43b	1.16a	0.11	0.320	0.032
E		0.54	0.36b	0.74a	0.54ab	0.39b	0.70a	0.06	0.075	0.039
K		0.34	0.19b	0.47a	0.36ab	0.23b	0.44a	0.04	0.040	0.023
A	Thigh	47.70	44.40b	50.66a	48.05ab	42.93b	52.47a	1.46	0.048	0.007
D		2.12	1.76b	2.45a	2.16a	1.92b	2.31a	0.09	0.035	0.036
E		1.91	1.67b	2.17a	1.91ab	1.17b	2.66a	0.21	0.084	0.003
K		1.12	0.88c	1.39a	1.11b	0.99b	1.25a	0.07	0.008	0.010

Means followed by the different letters in the same raw are significantly different (P<0.05). SEM: Pooled Standard Error of the Mean

Table 10. Effect of treatments and sex on water-soluble vitamins (ppm) in the breast and thigh

Water-soluble vitamins	Sample	Overall mean	Treatments			Sex		SEM	P-value	
			T0	T1	T2	M	F		Treatments	Sex
B2	Breast	7.65	6.80b	7.95a	8.20a	8.00a	7.30b	0.19	0.005	0.007
B3		8.22	7.45b	8.30ab	8.90a	9.47a	6.97b	0.37	0.058	0.007
B5		4.58	3.85c	4.80b	5.10a	5.30a	3.87b	0.24	0.002	0.001
B6		6.48	5.75b	6.70a	7.00a	6.93a	6.03b	0.19	0.017	0.012
B12		3.55	2.90c	3.70b	4.05a	3.87a	3.23b	0.15	0.002	0.003
C		6.50	5.75b	6.70ab	7.05a	7.07a	5.93b	0.22	0.054	0.026
B2	Thigh	6.38	5.70c	6.55b	6.90a	6.70a	6.07b	0.16	0.002	0.003
B3		6.35	5.80b	6.50a	6.75a	6.57a	6.13b	0.12	0.024	0.039
B5		3.18	2.65c	3.30b	3.60a	3.37a	3.00b	0.12	0.004	0.008
B6		4.95	4.40b	5.10a	5.35a	5.17a	4.73b	0.12	0.024	0.039
B12		2.67	2.10b	2.80ab	3.10a	3.03	2.30	0.16	0.081	0.053
C		4.83	4.25b	4.95a	5.30a	5.00	4.67	0.13	0.020	0.063

Means followed by the different letters in the same raw are significantly different (P<0.05). SEM: Pooled Standard Error of the Mean

Cholesterol: Cholesterol content (mg/100g) in the breast and thigh of the Pekin duck was shown in Table 11. The first group samples (T1) indicated lower content in the breast (34.50mg/100g) of cholesterol than the second group (T2) (35.30mg/100g) and control (T0) (45.55mg/100g) respectively, while thigh Cholesterol content was lower in the first group (86.85mg/100g) and the second group (T2) (87.75mg/100g) than the control group (T0) (97.30mg/100g). The replacement of the alfalfa pellet ration with the basal diet did not significantly influence ($p > 0.05$) cholesterol, and both the breast and thighs of males had a higher content of cholesterol than females (Table 11). In general, cholesterol content in the thigh was higher than breast which led to giving more beneficial health of the breast to humans than the thigh, especially for humans who had high blood pressure and cardiovascular diseases. Hadi *et al.*, (13), reported that the addition of Perilla seeds which contain a high percentage of fiber, fat, and protein had a significant effect ($p < 0.05$) on cholesterol levels in duck meat. The addition of Perilla seed tends to increase cholesterol levels in duck meat. However, Banaszak *et al.*, [4], reported that the using of lupin seeds as a replacement for soybean meal in the diet didn't have a significant effect on the cholesterol content in the breast muscle of Cherry Valley ducks. The study by Haraf *et al.*, [14], indicated that the cholesterol content in the examined muscles ranged from 57.88 to 72.31mg/100g of goose muscles. Higher cholesterol content in thigh meat was observed by Boz *et al.*, [6], for local Turkish goose varieties (74.95-77.85mg/100g). According to USDA [35], cholesterol content in raw goose thigh should equal 84mg/100g of muscle, which is higher than that determined in this study. In publications by other authors, the cholesterol content in the femoral muscles of broiler chickens was different (60.5-68.15mg/100g of muscle) 8. or higher (156.3-192.2mg/100g of muscle) (31).

Table 11. Effect of treatments and sex on cholesterol (mg/100g) in the breast and thigh muscles

Factors	Breast	Thigh
Overall mean	38.45	90.63
Treatments	NS	NS
T0	45.55±1.95	97.30±1.90
T1	34.50±5.00	86.85±6.75
T2	35.30±1.40	87.75±1.95
Sex	NS	NS
M	41.23±3.24	92.87±3.89
F	35.67±4.17	88.40±4.46

NS: Non-Significant (p > 0.05)

Fatty acid profile: The fatty acid profile of the breast and thigh is shown in Tables 12 and 13. The percentage of fatty acids was different among treatments. The content of saturated fatty acid in the breast and thigh (undecanoic, Myristic, Palmitic, and Stearic acid) was numerically and significantly ($p < 0.05$) higher in the second group (T2) than first (T1) and control group (T0) (Table 13). The highest content of saturated fatty acid in the breast and

thigh was recorded in the T2 treatment (50% alfalfa pellet ration). While the lower content of saturated fatty acid in the breast and thigh in the group were fed only a basal diet and they were significantly different ($p < 0.05$). In our results, birds feed 50% alfalfa pellet ration (T2) showed the highest ($p < 0.05$) content of unsaturated fatty acid (oleic%, Linoleic%, Arachidonic%, Linolenic%, Ericosenoic%) when compared to control group (T0). However, T1 and T2 did not show any significant differences. For the polyunsaturated fatty acids (PUFA) (Linoleic acid, Arachidonic, Linolenic), and monounsaturated fatty acids (MUFA) (Oleic, Ericosenoic), the control group recorded the lowest content of PUFA and MUFA, and the highest proportion was recorded for the second group (T2). The summation of PUFA, MUFA, SFA, n-3, n-6, and n-9 were varying in groups. The highest significant ($p < 0.05$) content of total PUFA, total MUFA, and total SFA in the breast and thigh, were recorded in the second group (T2). Also, breast and thigh females have higher numerically and significant ($p < 0.05$) content of most of all fatty acids than males (Table 12, 13). Saturated fatty acid (SFA) can have a negative impact on consumer healthy while monounsaturated fatty acid (MUFA) and polyunsaturated fatty acid (PUFA) are considered to have a positive effect on health. A similar finding in results by Wang *et al.*, [38] on China Micro-ducks at 57 days of age, who used different levels of Alfalfa meal in diet (0, 65, 130, and 205g/kg), indicated that the proportion of fatty acids increased with increasing levels of dietary crude fibers. However, Mustafa and Tayeb, (24) showed in their study on the local Kurdish slow-growing broiler fed organic feed, commercial feed with pasture in different level groups a significant difference ($p \leq 0.01$) on which that groups allowing access to the pasture gave high recorded significant differences in some fatty acid contents in the breast than other groups. The study by Kwiecien *et al.*, (22) on broilers that used two different doses of alfalfa protein concentrate 15g and 30g/kg, indicated that the chickens fed with alfalfa protein concentrate supplemented diets had higher contents ($p < 0.05$) of eicosadienoic and arachidonic acids and a lower level of saturated margaric (C17:0) and arachidic (C20:0) acids in the breast. However, had higher ($p < 0.05$) of eicosadienoic acids and arachidonic acids with a lower level ($p < 0.05$) of saturated palmitic and margaric acids as well as significantly lower content ($p < 0.01$) of arachidic acid in the thigh muscle, compared with the control group. Uhlirova *et al.*, (35), found that the effect of sex detected significant differences in the linoleic ($p<0.001$) and α-linolenic acid ($p=0.038$), total n-6 ($p=0.016$), and total PUFA ($p=0.028$) contents, all of which were higher in females than males. Furthermore, the higher content of α-linolenic acid in females could be explained by the role of steroid hormones (29).

Amino acid profile: The percentage of amino acids (essential and non-essential) in the breast and thigh of Pekin ducks are presented in Tables 14 and 15. The essential amino acids of those treatments fed alfalfa pellet ration were slightly higher compared to the groups fed on basal diets. Methionine and Lysin content (%) in the breast of the first group (T1) and the second group (T2) was (3.39, 6.65 T1 and 5.10, 4.03% T2) (Table 14), and in thigh content (%) (2.31% T1 and 4.25% T2) (Table 15). The contents of threonine, histidine, and cysteine that are related to the meat flavor [41] were found to some extent differences among all groups. Significant differences were found between treatments in breast samples of Histidine, Phenylalanine, and Leucine (Table 14), and in thigh samples of Methionine, Histidine, Phenylalanine, and Leucine (Table 15) which the second group (T2) recorded higher significantly ($p < 0.05$) content than other groups. In addition, all essential amino acids in the breast and thigh have been recorded including Valine, Leucine, Phenylalanine, Histidine, Tyrosine, and Methionine, and their percentage compared to the basal diet groups (T0) was higher (Table 14, 15). Each protein in the meat is distinguished by its content of amino acids and its amount in meat affects flavor substances. Also, amino acids in the meat protein are the precursors of meat smell (41). Generally, breast and thigh samples of females recorded higher content of all amino acids than males. The study by Wang *et al.*, (37), indicated that the proportion of some amino acids (Valine,

Leucine and Isoleucine) increased significantly ($p < 0.05$) with increasing levels of dietary crude fibers compared with control. Boz *et al.*, (6), noted that the effect of sex didn't have a significant ($p > 0.05$) effect on amino acids in the breast and thigh of Turkish goose varieties.

Table 12. Effect of treatments and sex on fatty acid profile (%) in the breast muscles

Fatty acid	Treatments			Sex		SEM	P-value	
	T0	T1	T2	M	F		Treatments	Sex
undecanoic acid (C11:0)	0.64c	0.78b	0.92a	0.69b	0.87a	0.04	0.006	0.004
Myristic (C14:0)	0.32b	0.39b	0.60a	0.38	0.49	0.04	0.027	0.068
Palmitic (C16:0)	9.60c	10.60b	11.70a	9.93b	11.33a	0.30	0.009	0.007
Stearic (C18:0)	2.30c	3.10b	3.90a	2.73b	3.47a	0.20	0.005	0.008
Oleic (C18:1) ω9	10.55c	11.80b	13.65a	10.97b	13.03a	0.44	0.017	0.013
Linoleic (C18:2) ω6	6.15b	7.15b	8.85a	6.80b	7.97a	0.34	0.023	0.040
Linolenic (C18:3) ω3	0.23b	0.33ab	0.50a	0.30	0.40	0.03	0.071	0.142
Ericosenoic (C20:1) ω9	0.46b	0.57b	0.84a	0.52b	0.72a	0.05	0.041	0.049
Arachidonic (C20:4) ω6	0.29b	0.42ab	0.58a	0.38	0.48	0.04	0.032	0.082
∑ MUFA	11.01b	12.37b	14.49a	11.48b	13.75a	1.19	0.019	0.015
∑ PUFA	6.67c	7.90b	9.93a	7.48b	8.85a	0.47	0.009	0.017
∑ UFA	17.67c	20.26b	24.41a	18.96b	22.60a	0.49	0.001	0.001
∑ SFA	12.86b	14.87b	17.12a	13.74b	16.16a	0.51	0.003	0.003
∑n-3	0.23b	0.33ab	0.50a	0.30	0.40	0.03	0.071	0.142
∑n-6	6.44b	7.57b	9.43a	7.18b	8.45a	0.70	0.016	0.030
∑ n-9	11.01b	12.37b	14.49a	11.48b	13.75a	1.19	0.019	0.015

Means followed by the different letters in the same raw are significantly different (P<0.05). SEM: Pooled Standard Error of the Mean. ∑ MUFA: Total of monounsaturated fatty acids. ∑ PUFA: Total of polyunsaturated fatty acids. ∑ UFA: Total of unsaturated fatty acids. ∑ SFA: Total of saturated fatty acids. ∑n-3: Total of omega 3. ∑n-6: Total of omega 6. ∑ n-9: Total of omega 9

Table 13. Effect of treatments and sex on fatty acid profile (%) in the thigh muscles

Fatty acid	treatments			Sex		SEM	P-value	
	T0	T1	T2	M	F		Treatments	Sex
undecanoic acid (C11:0)	1.15c	1.65b	2.20a	1.43b	1.90a	0.13	0.021	0.034
Myristic (C14:0)	0.78b	0.93b	1.26a	0.91b	1.06a	0.06	0.013	0.047
Palmitic (C16:0)	16.95b	18.15b	20.70a	17.03b	20.17a	0.60	0.014	0.007
Stearic (C18:0)	6.40b	7.45ab	9.25a	6.50b	8.90a	0.47	0.071	0.035
Oleic (C18:1) ω9	19.05b	20.35b	22.85a	19.10b	22.40a	0.62	0.018	0.009
Linoleic (C18:2) ω6	14.45b	15.95b	18.95a	14.90b	18.00a	0.66	0.039	0.028
Linolenic (C18:3) ω3	0.42b	0.49b	0.77a	0.49b	0.62a	0.16	0.015	0.044
Ericosenoic (C20:1) ω9	0.88	1.17	1.95	1.04	1.63	0.16	0.146	0.156
Arachidonic (C20:4) ω6	0.58b	0.76b	1.12a	0.68b	0.96a	0.07	0.017	0.021
∑ MUFA	19.93c	21.52b	24.80a	20.14b	24.03a	2.15	0.0003	0.0001
∑ PUFA	15.45b	17.20b	20.84a	16.07b	19.58a	1.11	0.021	0.017
∑ UFA	35.37c	38.72b	45.64a	36.21b	43.60a	0.95	0.007	0.004
∑ SFA	25.28c	28.18b	33.41a	25.88b	32.03a	0.89	0.002	0.001
∑n-3	0.42b	0.49b	0.77a	0.49b	0.62a	0.16	0.015	0.044
∑n-6	15.03b	16.71b	20.07a	15.58b	18.96a	1.65	0.027	0.021
∑ n-9	19.93c	21.52b	24.80a	20.14b	24.03a	2.15	0.0003	0.0001

Means followed by the different letters in the same raw are significantly different (P<0.05). SEM: Pooled Standard Error of the Mean. ∑ MUFA: Total of monounsaturated fatty acids. ∑ PUFA: Total of polyunsaturated fatty acids. ∑ UFA: Total of unsaturated fatty acids. ∑ SFA: Total of saturated fatty acids. ∑n-3: Total of omega 3. ∑n-6: Total of omega 6. ∑ n-9: Total of omega 9

Table 14. Effect of treatments and sex on amino acid profile (%) in the breast muscles

Amino acid	Treatments			sex		SEM	P-value	
	T0	T1	T2	M	F		Treatments	Sex
Aspartic (Asp)	2.84b	3.65ab	5.22a	3.50	4.30	0.31	0.098	0.225
Glutamic (Glu)	2.63b	3.45ab	5.06a	3.30	4.12	0.31	0.085	0.201
Asparagine (Asn)	2.16b	2.85ab	4.91a	2.90	3.71	0.35	0.054	0.178
Histidine (His)	2.19c	3.19b	4.98a	3.19	3.72	0.32	0.013	0.105
Serine (Ser)	2.89	3.38	5.10	3.31	4.27	0.31	0.122	0.194
Arginine (Arg)	3.13	4.05	5.62	3.81	4.72	0.33	0.120	0.231
Lysine (Lys)	3.25b	4.03b	6.65a	4.23	5.06	0.41	0.014	0.075
Methionine (Met)	2.46b	3.39b	5.10a	3.25	4.05	0.32	0.033	0.107
Alanine (Ala)	3.80	4.42	5.97	4.20	5.26	0.33	0.191	0.232
Valine (Val)	3.35	3.60	5.63	3.53	4.85	0.38	0.194	0.201
Proline (Pro)	2.74	3.61	5.25	3.42	4.30	0.33	0.110	0.229
Phenylalanine (Phe)	2.80b	3.63b	6.11a	3.80	4.56	0.39	0.009	0.055
Leucine (Leu)	2.63b	3.54b	5.94a	3.57	4.50	0.40	0.019	0.076
Tyrosine (Tyr)	2.57b	3.32ab	5.37a	3.27	4.23	0.36	0.065	0.159

Means followed by the different letters in the same raw are significantly different (P<0.05). SEM: Pooled Standard Error of the Mean

Table 15. Effect of treatments and sex on amino acid profile (%) in the thigh muscles

Amino acid	Treatments			sex		SEM	P-value	
	T0	T1	T2	M	F		Treatments	Sex
Aspartic (Asp)	1.95b	2.85ab	4.40a	2.73	3.40	0.30	0.062	0.211
Glutamic (Glu)	1.98b	2.77b	4.18a	2.69	3.26	0.26	0.026	0.116
Asparagine (Asn)	1.52b	1.79b	3.78a	2.05	2.68	0.29	0.029	0.124
Histidine (His)	1.61b	2.20b	4.12a	2.30	2.99	0.30	0.015	0.065
Serine (Ser)	2.34	2.45	4.23	2.57	3.43	0.28	0.104	0.177
Arginine (Arg)	2.55	2.78	4.83	2.93	3.83	0.33	0.099	0.202
Lysine (Lys)	2.80b	3.40b	5.35a	3.53	4.17	0.31	0.017	0.089
Methionine (Met)	1.81b	2.31b	4.25a	2.50	3.08	0.30	0.015	0.088
Alanine (Ala)	3.19	3.59	5.17	3.44	4.51	0.31	0.184	0.203
Valine (Val)	2.58	2.41	4.63	2.57	3.84	0.36	0.178	0.196
Proline (Pro)	2.04b	2.72b	4.48a	2.72	3.44	0.30	0.038	0.127
Phenylalanine (Phe)	2.27b	2.61b	5.01a	2.96	3.63	0.34	0.012	0.074
Leucine (Leu)	2.14b	2.67b	4.74a	2.83	3.52	0.32	0.017	0.082
Tyrosine (Tyr)	1.97b	2.50b	4.46a	2.56	3.39	0.32	0.036	0.105

Means followed by the different letters in the same raw are significantly different (P<0.05). SEM: Pooled Standard Error of the Mean

This study showed that among the treatments, birds fed diet replacement with Alfalfa pellet ration beneficially influenced meat quality in comparison with those fed only basal diets. So, the replacement of the Alfalfa pellet ration influenced positively on most Physico-chemical traits. Feeding ducks with a 25% of Alfalfa pellet ration improved in terms of color breast, and fat-soluble vitamins with Cholesterol in both breast and thigh muscle while feeding ducks with a 50% Alfalfa pellet ration improved most Physico-chemical traits. Furthermore, the breast and thighs of females had a higher content of protein%, fat%, amino acid profile, fatty acid profile, and fat-soluble vitamins than males.

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